CLOSED LOOP SYSTEM FOR RENEWABLE ENERGY WITH IMPROVED DYNAMIC RESPONSE USING SEPIC CONVERTER

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Article History: Received: 12.12.2022 **Revised:** 29.01.2023 **Accepted:** 15.03.2023

Abstract

This study analyzes a confined PID, SEPIC-controlled excitation system for a synchronized kind generator that is utilized in wind turbine technology. The Alternator's Output Process Value in Volts is approximated and compared to the Stipulated Voltage. The error voltage, which is derived from the difference between the output and the reference voltage, is used to tune the DC to DC SEPIC Convertor's obligation ratio. Using PI and PID regulators, the open loop and closed - loop designs are simulated, and the comparing outcomes are reported. To control the field current of the alternator system, a SEPIC converter is suggested.

Keywords: RE – Renewable Energy, Excitation, Alternator, SEPIC Converter, PI & PID Controllers, MATLAB and Closed loop system.

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DOI: 10.31838/ecb/2023.12.s3.081

1. Introduction

The academicians are doing innovative work exercises in wind turbines, with a focus on the design, mechanical layout, power supply system, and other aspects of the wind turbine. Electrical equipment plays a crucial role in the development of wind turbines. A hybrid excitation mechanism is used for the wind turbines' backup power supply unit. The auxiliary stuff box installed on the wind turbine provides the mechanical support for the wind turbine excitation system. A typical shaft is connected to the Permanent magnet synchronized generator, Inverted simultaneous generator, and Synchronous generator. The chopper circuit maintains a constant result voltage. Modern wind turbine generators provide two main dispersion power transports using their speed and output force, such as high power 3Φ, 115V AC, 400Hz and low power 28V DC.

When it's necessary to regulate the output voltage in non-isolated DC-to-DC converters over a wide range of values, the SEPIC converter makes sense. It means that the outcome voltage could differ from the information voltage in magnitude. The SEPIC converter is useful because the result voltage level might be lower than the DC input voltage, which makes it less attractive to use a converter with an inductor at the front end in high-power factor applications. In light of the reduction in responsive part size and cost, the high-recurrence activity in the SEPIC converter, as in all DC-to-DC converters, is alluring. The SEPIC converters offer a few advantages in PFC applications, such as straightforward transformer detachment and standard security against inrush current happening at fire up or over-burden current, lower input current wave, and less EMI related with the broken conduction mode (DCM) geography.

The main goals of SEPIC converters are to reduce exchanging or conduction unlock, reduce part estimations, increase framework productivity, relieve voltage or current pressure, speed up transient responses, etc. The SEPIC converter is used to deliver DC power to wind turbines with a stockpile voltage of 14V, 24V, and 48V recurrence of 360Hz to 850Hz. It was used in the adjacent planet group with the most extreme power direct technique to extract the greatest power.

System Description

Fig. 1 shows the conventional block diagram of the recorded excitation structure for wind turbine use. In this circuit, the yield voltage and the reference voltage were already in contrast, and the PI regulator was impacted by this error. The switch in the lift converter is controlled by the PI regulator's output. More motions are delivered by this circuit before it reaches the constant state yield voltage.

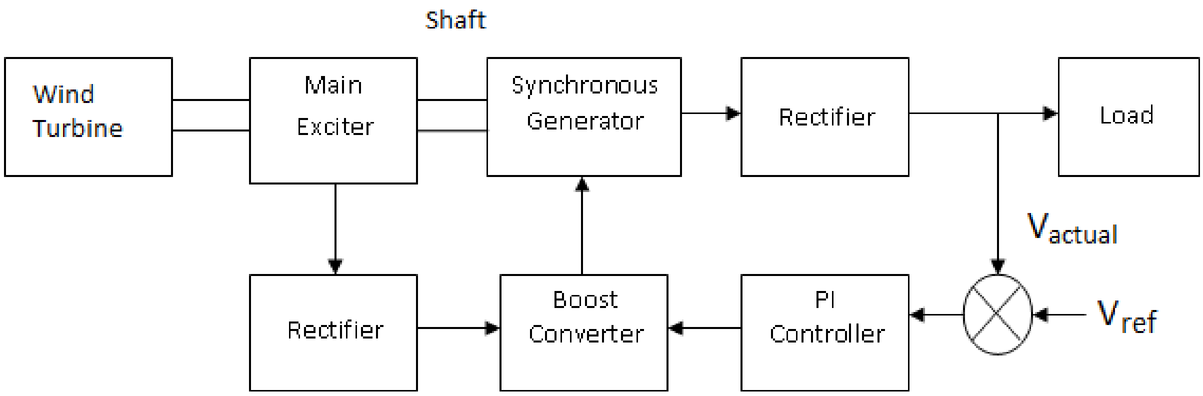

Fig.1 Block Diagram of Field Excitation System for Wind Turbines

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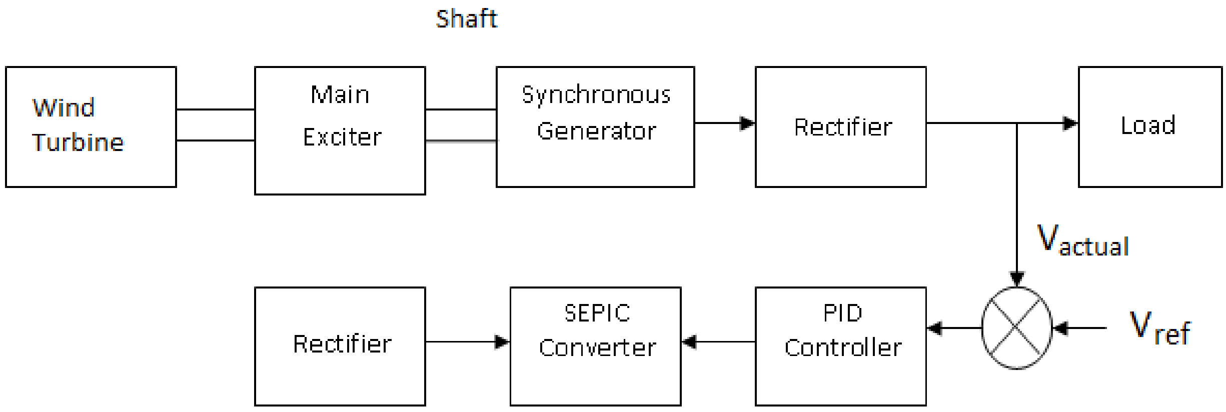

Fig.2 Block Diagram of Proposed Field Excitation System

2. Simulation Results

This section discusses the recreation examination using MATLAB of three different closed circle excitation frameworks: one with a PI regulator, one with a PID regulator, and one with an open circle excitation framework.

Open loop excitation system

Fig. 3a shows the circuit diagram for the open circle controlled framework. At t = 1sec, a stage shift in the yield voltage is taken into account. The alternator's AC output is changed by using an unregulated rectifier. The field of the alternator receives the rectifier's DC output. An obstruction and an inductance are used in series to illustrate the field winding. As seen in Fig. 3b, the alternator's output voltage increases at t = 1 second. The rectifier's output voltage is shown in Fig. 3c in increments. The result current also increases, as shown in Fig. 3d.

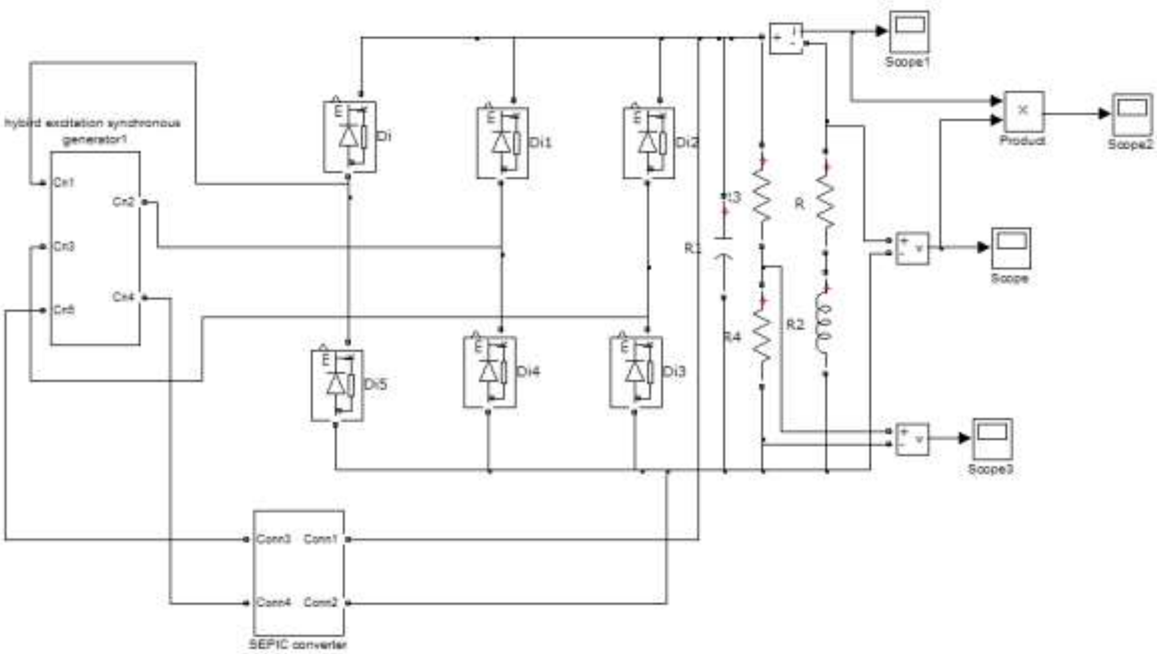

Fig. 3a Circuit Model of the Open Loop System

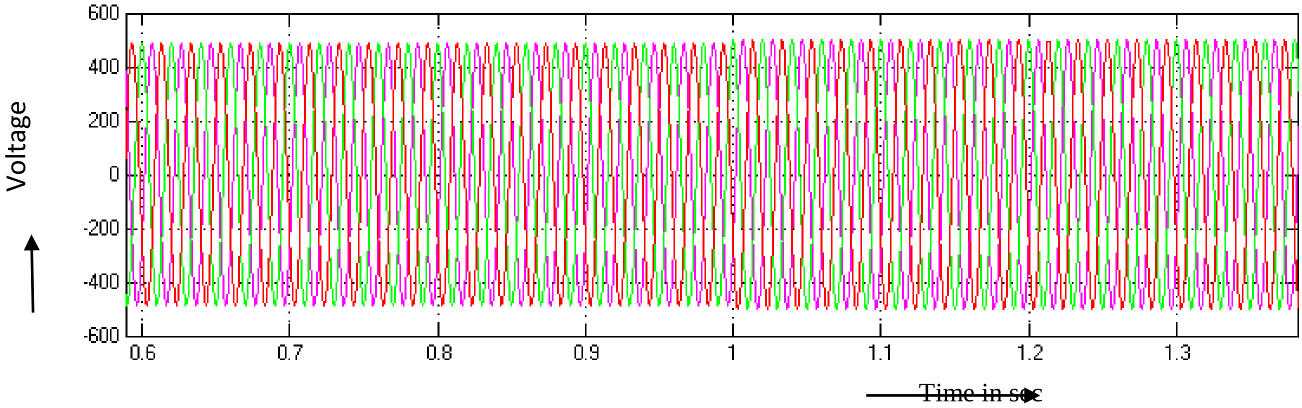

Fig. 3b Output Voltage of the Alternator

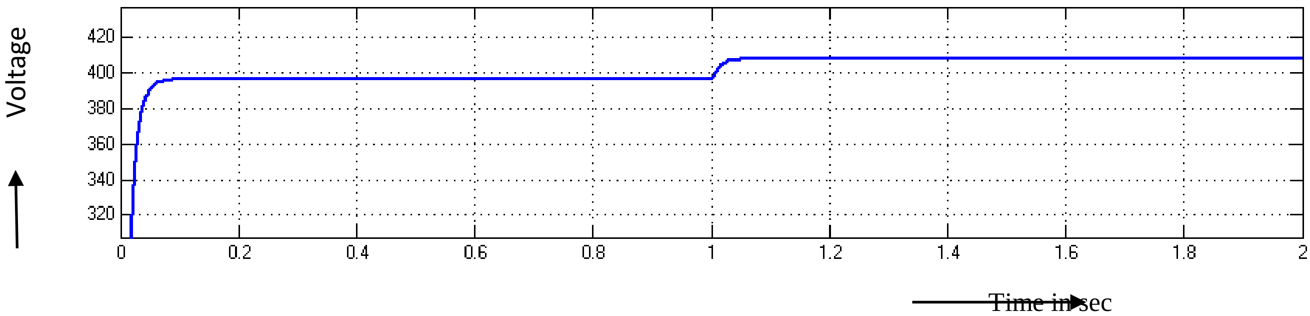

Fig. 3c Output Voltage of the Rectifier

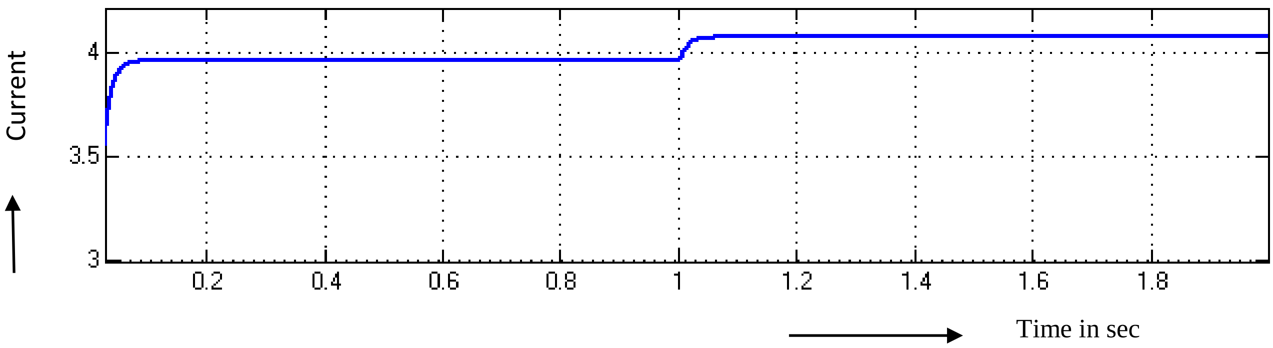

Fig. 3d Output Current of the Rectifier

Closed loop Excitation System with PI controller

Fig. 4a shows the closed circle framework's circuit model. The measured result voltage is compared to the reference voltage. The error is used to regulate the SEPIC converter's obligation percentage. Fig. 4b shows the shut circle framework's outcome voltage. In Fig. 4c, the rectifier's voltage is shown. It is quite likely that at t = 1.4 seconds, the result voltage falls to its usual value. Therefore, the consistent state error in the closed-circle framework's result voltage is significantly lower than in the open-circle framework. According to the following, the circuit makes its decisions.

C = 2200µF, R_f = 100 Ω, L_f = 1 mH, K_P = 0.8 and K_I = 1.8 Kd = 0.9

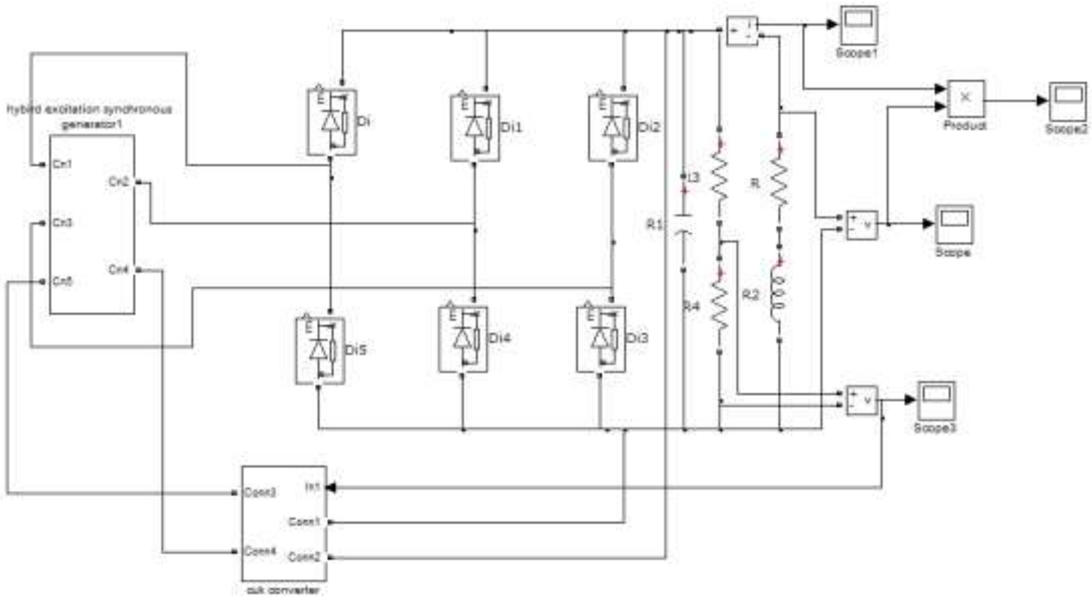

Fig. 4a Closed Loop Controlled System with the PI Controller

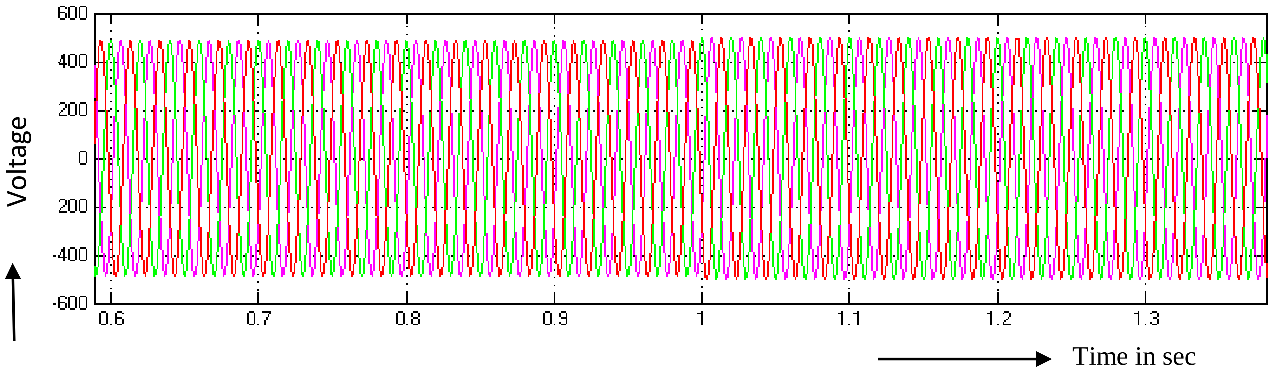

Fig. 4b Output Voltage of the Alternator

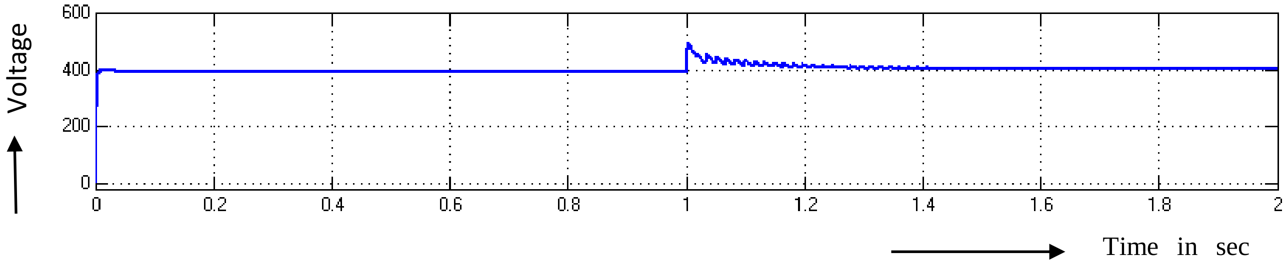

Fig. 4c Output Voltage of the Rectifier

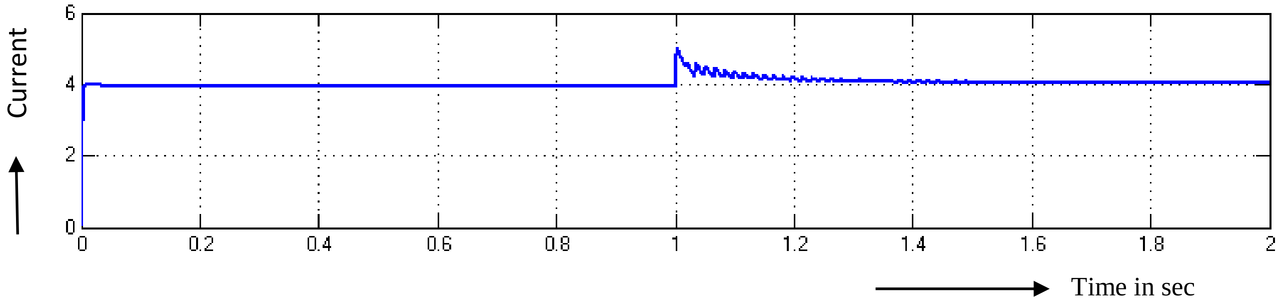

Figure 5a shows the PID logic controlled shut circle excitation architecture. The alternator's field twisting voltage is measured and contrasted with the reference voltage. The mistake is used as a component of the PID rationale regulator. In order to maintain a constant voltage across the field winding, PID's output modifies the beat width. Because of the acceleration, the generator's output expands. As shown in figure 5b, the voltage across the rectifier increases as a result. Figures 5c show the results as they currently stand with the PID reasoning regulator. Table 2 provides an analysis of reactions using the PI and PID rationale regulator. It can be seen in the Table and waveforms, from the waveforms and the Table, it very well may be seen that the reaction with PID rationale regulator is quicker and smoother.

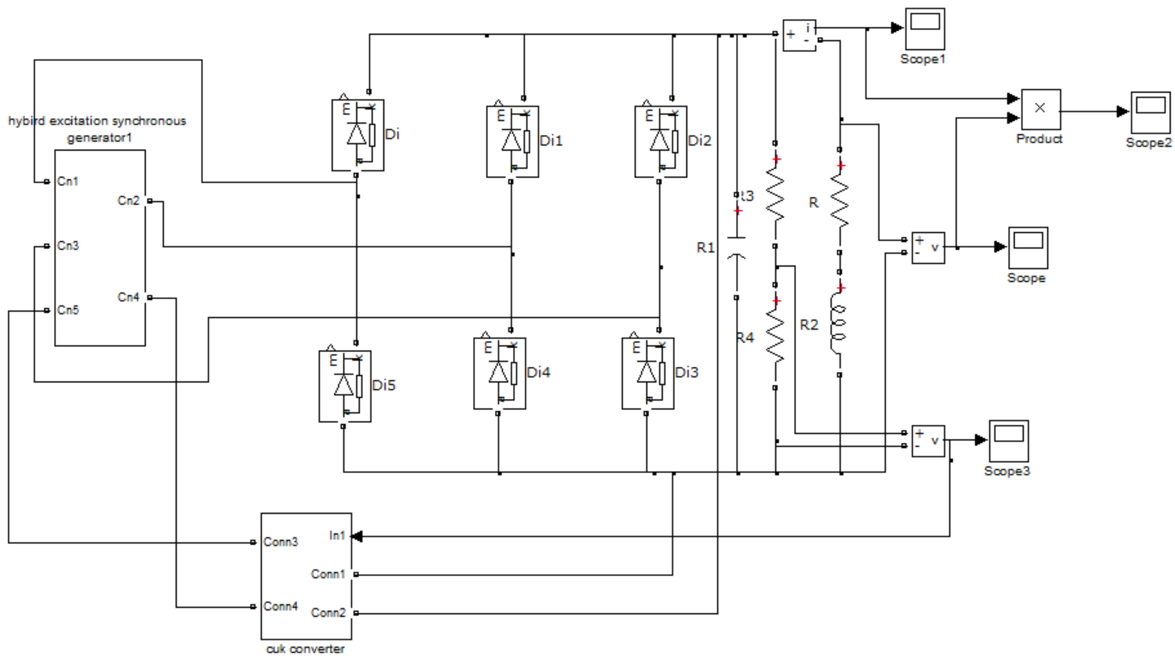

Fig. 5a Simulink Model of Closed Loop System with PID

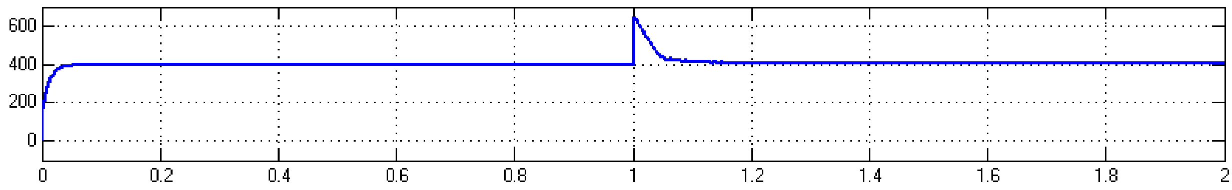

Fig.5b Output Voltage of the Rectifier

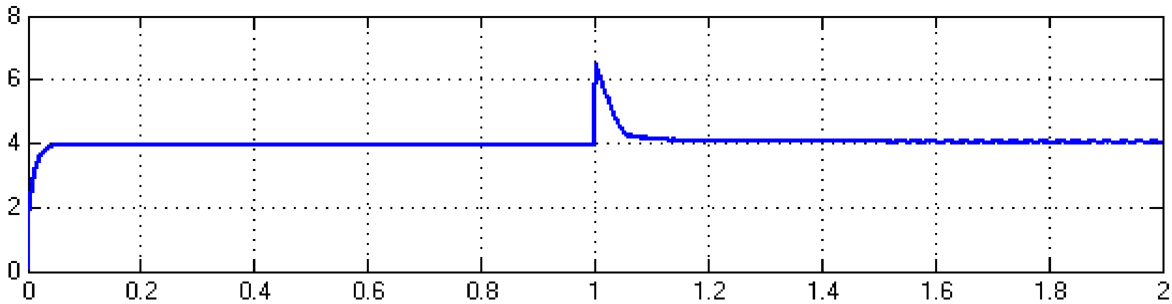

Fig.5c Output Current of the Rectifier

Table 2: Comparison of Responses with PI & PID Controllers

Controllers	T_r	T_s	T_p	E_{ss}
PI	**0.019**	**1.23**	**1.15**	**0.9**
PID	**0.013**	**1.1**	**1.12**	**0.53**

3. Conclusion

The results of a successful demonstration and replication of a closed loop controlled solid - state power excitation system for a simultaneous generator using MATLAB Simulink were presented. The closed loop method's edges are set to produce a constant voltage at the alternator's output. The results of the looped simulation, which used both PI and PID regulators, show that the PID-controlled closed-circle framework performed better than PI-controlled framework. The reproduction outcomes matched the expectations. Benefits of this system include lower costs, fewer components, and improved unwavering quality. The disadvantage of the SEPIC converter was that it was frequently only used with low power alternators.

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